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INDUSTRIAL ENGINEERING DIVISION

Lake City Arsenal

Independence, Missouri

STUDY OF HEAVY PELLET M52A3B1 ELECTRIC PRIMERS

I. E. D. REPORT NR. 61-9



XEROX

PROJECT: OAC

56-184

56-184-1-1

JUNE 1961

\$3.60

Industrial Engineering Division
Lake City Arsenal
Independence, Missouri

STUDY OF HEAVY PELLET M52A3BL ELECTRIC PRIMERS


Industrial Engineering Division
Report No. 61-9


Project No. OAC 56-184
Subproject No. OAC 56-184-I-1

June 1961

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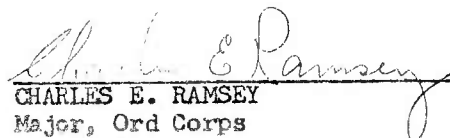

CHARLES E. RAMSEY
Major, Ord Corps
Commanding

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I. ABSTRACT

The purpose of this test program was to determine what effect heavy weight pellets in M52A3B1 electric primers would have on the pressure level of 20mm M55 Ball ammunition loaded with WC 870 ball propellant. The normal pellet weight selected was 2.75 gr. and the heavy pellet weight was 3.00 gr. No significant difference in pressure levels was observed for the pellet weight difference considered.

II. INTRODUCTION

Control of pellet weight in the electric primer M52A3B1 became of primary importance with the introduction of the Gatling-type, high cyclic rate, electrically operated automatic weapon for use in aircraft.

A method was developed for control of the lower limit in the permissible pellet weight range to insure freedom from light weights, which were known to be a cause of long action time. Such control was then made a primer specification requirement.

No formal specification provisions were made, however, for the control of the upper limit of the pellet weight range as no malfunctioning or other undesirable ballistics was anticipated from overweight pellets of the magnitude expected.

Subsequently work was conducted at Frankford Arsenal on pellet weight versus pressure in weight ranges around 4.0 grains and dangerously high chamber pressures were developed.

It was therefore concluded that an investigation of pellet weight versus pressure in the weight range from 3.0 to 3.5 grains should be conducted. This weight range was chosen because 3.0 grains was the maximum permitted on the applicable drawing (74-2-79). It had also been determined previously in studies conducted by both the Olin-Mathieson Chemical Corporation and the Remington Arms Company that the maximum weight which might be expected, even when pellet weight controls during manufacture where in the upper range, was approximately 3.25 grains.

This program was then undertaken to determine whether more positive manufacturing controls should be applied to the upper limit of primer pellet weight, and whether a requirement for such control should be added to the electric primer specification, OAC-PD-28.

III. PROCEDURE

Two groups of M52A3B1 electric primers, having normal (2.75 grains nominal) and heavy (3.00 grains nominal) weight pellets, were obtained from each of two primer manufacturers, Western Cartridge Division, Olin-Mathieson Corp., and Remington Arms Company, Lake City Arsenal. Extreme pellet weight spread, for both normal and heavy weights, was approximately .6 grains. These primers were then assembled into complete rounds and segregated into various subgroups for the required test program, which was divided into two phases.

In the phase I portion of the program the Remington Arms Company-LCA primers were assembled into 20MM M55A1 Ball cartridges using M103 cases,

M55A1 ball projectiles and IMR 7005 type propellant. The propellant charge established (593 grains) for the particular propellant lot to yield service velocity (3380 \pm 50 fps) was used. The same propellant charge was adequate for both normal and heavy weight primer pellets. Identity of the test cartridges having normal primer pellets and those having heavy pellets was maintained using lot number 257A for the normal weight and 257B for the heavy weight. These cartridges were then fired for velocity, pressure and action time at both ambient and cold (-65°F) temperatures.

In the phase II portion of the program the primers of Olin-Mathieson Corp. manufacture were assembled into 20MM M55A1 Ball cartridges using M103 cases and M55A1 projectiles. Loading with IMR 7005 and WC 870 ball types of propellants was accomplished as follows: IMR type, normal and heavy pellet weight primers, 10 cartridges each at 575, 580, 585, 590 and 595 grains; WC 870 ball type, normal and heavy pellet weight primers, 10 each at 595, 600, 605, 610 and 615 grains. These test cartridges were then fired for velocity, pressure and action time, the cartridges for all tests being at ambient temperature. Forty-five (45) cartridges in each of the four primer-propellant categories were loaded to charges established to produce service velocity. Forty cartridges of each group were fired for function in an M39 gun and P-T traces, using a Piezo cage, were obtained on the remaining five cartridges.

IV. RESULTS

The phase II firings for velocity and pressure are graphically compared on charts A and B, while the action time results are shown on chart C. A tabulation of the velocities and pressures, only, for both phases is given below. Complete results are contained in appendix B.

Phase I

<u>IMR 7005</u> <u>Propellant</u>	<u>Temperature</u>	<u>Average</u> <u>Velocity</u> (Corr.)	<u>Average</u> <u>Pressure</u> (Corr.)	<u>Action Time</u>
Normal Primer	Ambient	3394 f/s	50900 psi	2.61 ms
Heavy Primer	Ambient	3416	52150	2.61
Normal Primer	-65°	3360	54000	2.69
Heavy Primer	-65°	3368	52750	*

* Insufficient ammunition was available to complete the action time firings.

Phase II

<u>IMR 7005</u>	<u>575 gr.</u>	<u>580 gr.</u>	<u>585 gr.</u>	<u>590 gr.</u>	<u>595 gr.</u>
Velocity (Corr.)					
Normal Primer	3368 f/s	3388	3409	3429	3446
Heavy Primer	3377	3396	3421	3437	3447
Pressure (Corr.)					
Normal Primer	52340 psi	53740	54780	55720	56430
Heavy Primer	53700	54380	56290	56440	56720

<u>WC 870 Ball</u>	<u>595 gr.</u>	<u>600 gr.</u>	<u>605 gr.</u>	<u>610 gr.</u>	<u>615 gr.</u>
Velocity (Corr.)					
Normal Primer	3346 f/s	3357	3380	3415	3440
Heavy Primer	3315	3334	3360	3382	3392
Pressure (Corr.)					
Normal Primer	48330 psi	48910	51500	53260	54900
Heavy Primer	46430	47180	49040	50270	50890

It will be noted from the above tabulations and the charts covering phase II testing that with IMR type propellant velocity and pressure levels increased in ammunition primed with heavy pellet primers and action time decreased. With the WC ball type propellant, however, the velocity and pressure levels decreased in ammunition primed with heavy pellet primers and there was no significant difference in action time.

Phase I firings conducted at ambient temperatures using the same IMR propellant charge weight for both normal and heavy primer pellet weights also showed higher velocity and pressure levels for the heavy pellet primer. In the cold temperature (-65°F) tests for this phase, however, the pressure levels apparently were reversed and the cartridges having heavy pellet primers had a lower pressure than those with the normal pellet primers. Further, the pressure level of the cartridges with normal primer pellet weight was higher at cold temperature than at ambient temperature. Neither of these results can be explained and possibly are spurious.

The pressure-time traces for the two primer pellet weights using IMR propellant, at ambient temperature, showed no significant differences in either rate of pressure rise or peak pressure. The curves for the WC ball propellant showed a slower rate of rise and a lower peak pressure for the heavy primer pellet as compared with the normal primer pellet.

V. CONCLUSIONS

The results of the various tests conducted using IMR and ball propellants with normal and heavy weight primer pellets demonstrate that no adverse effect, so far as velocity and pressure are concerned, is obtained with heavy weight primer pellets in the range used (max. 3.25 gr.).

Somewhat better ignition was obtained with IMR propellant with the heavier pellet as evidenced by the slight increase in velocity and pressure and lower action time.

With ball propellant, action time remained relatively constant, whereas, there was a slight drop in the velocity and pressure level with the heavier pellet. This may result from a larger amount of unburned propellant being expelled from the barrel because of the increased brisance of the heavier primer pellet. This assumption is based on the fact that with ball powder, under normal conditions, a greater amount of unburned powder is expelled than is the case with IMR propellant. It also may indicate that, with the heavy primer pellet, to obtain the desired velocity level a slight reduction in charge with IMR propellant is possible, whereas, with ball propellant the charge would increase.

VI. RECOMMENDATIONS

The performance of 20MM M55A1 Ball ammunition assembled with primers having heavy weight (3.0 - 3.25 grs) primer pellets indicated that no adverse effect on velocity, pressure or action time results from such overpriming. The limited M39 function firing did not reveal any increased percentage incidence of primer casualties. Therefore, control of the upper limit of the primer pellet weight range is not critical and it is recommended that no formal quality assurance be established for its control.

Establishment of such a quality assurance would increase unnecessarily the cost of the M52A3B1 electric primer.

APPENDIX A
DETAILED FIRING REPORTS AND MISFIRE ANALYSIS

Subject: Test Request Nr. 211259

Object: To determine difference in pressure level of regular and heavy weight pellet M52A3B1 primer of W. C. manufacture.

Lot Nrs: IED 27-261, IMR Propellant

IED 27-262, W. C. 870 Ball Propellant

Dates of Firing: 16 thru 18 July 1957, inclusive

I. Test Procedure

A. Velocity, pressure and action time

1. The test ammunition was loaded as follows:

Number of Rounds		Propellant Type	Army Lot	Charge (Grs.)
Normal Primer	Heavy Primer			
10	10	IMR 7005	41892	575
10	10	IMR 7005	41892	580
10	10	IMR 7005	41892	585
10	10	IMR 7005	41892	590
10	10	IMR 7005	41892	595
10	10	W. C. 870	41940	595
10	10	W. C. 870	41940	600
10	10	W. C. 870	41940	605
10	10	W. C. 870	41940	610
10	10	W. C. 870	41940	615

2. The test was fired through a standard pressure test barrel using standard velocity and pressure procedures.

3. The Aberdeen Proving Ground chronograph was used for instrumentation to record the action time.

4. All phases of the test loaded with IMR type propellant was fired prior to firing the W. C. ball propellant.

B. Piazos; time-pressure

1. The following groups and quantities were fired for time pressure using the Piazos electric gage.

Number of Rounds		Propellant Type	Army Lot	Charge (Grs.)
Normal Primer	Heavy Primer			
5	5	IMR 7005	41892	585
5	5	W. C. 870	41940	610

C. Function and casualty, M39A1 gun

1. The following groups and quantities were fired for primer leaks in the M39A1 gun.

Number of Rounds		Propellant Type	Army Lot	Charge (Grs.)
<u>Normal Primer</u>	<u>Heavy Primer</u>			
40	40	IMR 7005	41892	585
40	40	W. C. 870	41940	610

II. Results

- A. See attached sheet.

II. Results

A. Velocity, pressure and action time

IMR Propel- lant Charge	575 Grs		580 Grs		585 Grs		590 Grs		595 Grs	
	Norm	Prmr	Norm	Prmr	Norm	Prmr	Norm	Prmr	Norm	Prmr
Velocity, f/s	3368	3377	3388	3396	3409	3421	3429	3437	3446	3447
Std. Dev.	15.0	7.0	8.0	10.0	10.0	6.0	7.0	8.0	11.0	7.0
Pressure, psi	52340	53700	53740	54380	54780	56290	55720	56440	56430	56720
Std. Dev.	1400	800	700	1300	800	1100	1000	1000	1200	1200
Av. Action Time m/s	2.63	2.59	2.61	2.55	2.59	2.54	2.57	2.53	2.58	2.53

WC 870 Ball Pro- pellant Charge	595 Grs		600 Grs		605 Grs		610 Grs		615 Grs	
	Norm	Prmr	Norm	Prmr	Norm	Prmr	Norm	Prmr	Norm	Prmr
Velocity, f/s	3346	3315	3357	3334	3388	3360	3415	3382	3440	3398
Std. Dev.	18.0	5.0	20.0	4.0	25.0	12.0	18.0	9.0	19.0	14.0
Pressure, psi	48330	46430	48910	47180	51500	49040	53260	50270	54900	50890
Std. Dev.	1800	700	1700	800	2300	1300	1700	800	1400	1700
Av. Action Time, m/s	2.65	2.63	2.62	2.62	2.59	2.60	2.57	2.58	2.54	2.54

B. Piaz; time-pressure

	Velocity, f/s	
	Normal Primer	Heavy Primer
Five (5) rounds, IMR Propellant, Charge 585 Grs.	3416	3414
Five (5) rounds, W.C. 870, Ball Propellant, Charge 610 Grs.	3420	3388

Photographs of the time pressure curve are inclosed in this report.

C. Machine gun function and casualty, M39A1 gun

Rounds Fired	Primer	Propellant Type	Results
40	Normal	IMR 7005	Three (3) small escape of gas
40	Heavy	IMR 7005	One (1) very small escape of gas
40	Normal	W.C. 870	Two (2) small escape of gas
40	Heavy	W.C. 870	One (1) small escape of gas

LAKE CITY ARSENAL						Test Request Nr.	
VELOCITY & PRESSURE - ACCEPTANCE REPORT						211253	
Nomenclature Elec., 20MM (steel cases) (AMBIENT)					Lot No IED 27-257 Group A (I)		Date Tested
RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE
				Elec.	64	637	-
					Velocity Tested at 78 Feet		
VELOCITY F.S.			PRESSURE P.S.I.		Barometer 29.43 Inches		
DRY		WET			FIRING DRY 76 °F		
					WET 66 °F		
Corr. Mean			Corr. Mean		ROOM R. H. 59 %		
Mean Inst.	3384		Mean Inst.		Instrument Room 76 °F		
Max. Inst.	3421		Max. Inst.		Ammunition 70 °F		
Min. Inst.	3360		Min. Inst.		Range Temperature 76 °F		
Ex. Var.	61		Ex. Var.		Velocity Barrel Corr. F.S.		
Std. Dev.	15.0		Std. Dev.		Pressure Barrel Corr. P.S.I.		
SHOT No.	DRY		WATERPROOF		VELOCITY IN GAGE		PRESSURE
CHECK AMMUNITION							
Value _____ F.S.							
_____ PSI							
1	3363	48500					
2	3385	50900					
3	3387	50200					
4	3360	48200					
5	3379	50600					
6	3377	50600					
7	3386	50700					
8	3419	51400					
9	3395	51300					
10	3377	50300					
11	3368	50500					
12	3381	49800					
13	3381	49600					
14	3379	51000					
15	3369	49200					
16	3378	49800					
17	3421	50600					
18	3386	51500					
19	3396	51500					
20	3387	51800					
Total	67674	1008100					
Mean	3384	50405					
REMARKS:							
IMR 7005, AL 41313, Chg. 593.0							

LAKE CITY ARSENAL						Test Request Nr.		
VELOCITY & PRESSURE - ACCEPTANCE REPORT						211253		
Nomenclature Elec., 20MM (steel cases) (AMBIENT)					Lot No IED 27-257 Group A (II)		Date Tested	
RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	
				Elec.	64	637	-	
					Velocity Tested at		Foot	
VELOCITY F.S.			PRESSURE P.S.I.		Barometer		Inches	
	DRY	WET			FIRING	DRY	°F	
Corr. Mean			Corr. Mean		ROOM	WET	°F	
Mean Inst.	3396		Mean Inst.	51200		R. H.	%	
Max. Inst.	3416		Max. Inst.	52400	Instrument Room °F			
Min. Inst.	3379		Min. Inst.	49600	Ammunition °F			
Ex. Var.	37		Ex. Var.	2800	Range Temperature °F			
Std. Dev.	12.0		Std. Dev.	800	Velocity Barrel Corr. F.S.			
					Pressure Barrel Corr. P.S.I.			
SHOT No.	DRY		WATERPROOF		VELOCITY IN GAGE		PRESSURE	CHECK AMMUNITION
								Value _____ F.S. _____ PSI
1	3392	50300						
2	3395	50400						
3	3392	51300						
4	3396	50800						
5	3392	50600						
6	3382	50700						
7	3406	50500						
8	3403	51400						
9	3388	49600						
10	3400	51000						
11	3416	52300						
12	3379	51000						
13	3399	51800						
14	3410	51900						
15	3381	50900						
16	3389	52400						
17	3381	52300						
18	3416	52300						
19	3385	50200						
20	3413	52300						
Total	67915	1024000						
Mean	3396	51200						
REMARKS:								
IMR 7005, AL 41313, Chg. 505.0								

LAKE CITY ARSENAL						Test Request Nr. 211253		
VELOCITY & PRESSURE - ACCEPTANCE REPORT								
Manufacturer Blaco, 20MM (steel cases) (AMBIENT)					Lot No LRD 27-257 Group A (III)		Date Tested	
RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	
VELOCITY F.S.				PRESSURE P.S.I.				
DRY		WET		DRY		WET		
Corr. Mean				Corr. Mean				
Mean Inst.	3402			Mean Inst.	50980			
Max. Inst.	3428			Max. Inst.	53400			
Min. Inst.	3372			Min. Inst.	47400			
Ex. Var.	59			Ex. Var.	6000			
Std. Dev.	13.0			Std. Dev.	1200			
Velocity Tested at				79 Feet				
Barometer				29.43 Inches				
FIRING DRY				76 °F				
ROOM WET				66 °F				
R. H.				59 %				
Instrument Room				76 °F				
Ammunition				70 °F				
Range Temperature				76 °F				
Velocity Barrel Corr.				F.S.				
Pressure Barrel Corr.				P.S.I.				
SHOT No.	DRY		WATERPROOF		VELOCITY IN GAGE		PRESSURE	CHECK AMMUNITION
								Value F.S. PSI
1	3392	50400						
2	3392	51100						
3	3372	47400						
4	3388	49900						
5	3409	50700						
6	3400	51000						
7	3422	52900						
8	3400	49800						
9	3393	50900						
10	3414	52500						
11	3400	51700						
12	3392	50700						
13	3395	51000						
14	3428	53400						
15	3420	50700						
16	3409	51300						
17	3394	50600						
18	3410	50600						
19	3400	51700						
20	3418	51100						
Total	68048	1019600						
Mean	3402	50980						
REMARKS:								
IMR 7005, AL 41813, Csg. 503.00								

LAKE CITY ARSENAL						Test Request Nr.		
VELOCITY & PRESSURE - ACCEPTANCE REPORT						211253		
Nomenclature					Lot No		Date Tested	
Elec., 20MM (steel cases)					IED 27-257			
(AMBIENT)					Group B (I)			
RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	
				Elec.	64	658	-	
					Velocity Tested at 78 Feet			
VELOCITY F.S.			PRESSURE P.S.I.		Barometer 29.43 Inches			
DRY		WET			FIRING DRY 76 °F			
					ROOM WET 66 °F			
Corr. Mean			Corr. Mean		R. H. 59 %			
Mean Inst.	3418		Mean Inst.	52260	Instrument Room 76 °F			
Max. Inst.	3438		Max. Inst.	54400	Ammunition 70 °F			
Mln. Inst.	3387		Mln. Inst.	49200	Range Temperature 76 °F			
Ex. Var.	51		Ex. Var.	5200	Velocity Barrel Corr. F.S.			
Std. Dev.	11.0		Std. Dev.	1300	Pressure Barrel Corr. P.S.I.			
SHOT No.	DRY		WATERPROOF		VELOCITY IN GAGE		PRESSURE	CHECK AMMUNITION
								Value F.S. PSI
1	3387	49200						
2	3429	54400						
3	3411	50900						
4	3422	52400						
5	3420	52300						
6	3428	52000						
7	3414	51600						
8	3415	51800						
9	3415	51100						
10	3424	52200						
11	3417	51800						
12	3417	52400						
13	3397	50300						
14	3410	52700						
15	3421	52400						
16	3418	52900						
17	3430	53900						
18	3428	53000						
19	3438	54300						
20	3423	53600						
Total	68364	1045200						
Mean	3418	52260						
REMARKS:								
IMR 7005, AL 41313, Chg. 503.0								

LAKE CITY ARSENAL						Test Request			
VELOCITY & PRESSURE - ACCEPTANCE REPORT						Nr. 211253			
Nomenclature				Lot No		Date Tested			
Elec., 20MM (steel cases) (AMBIENT)				IED 27-257 Group B (II)					
RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE		
				Elec.	64	658	-		
				Velocity Tested at 78 Feet					
VELOCITY F.S.				PRESSURE P.S.I.					
DRY		WET							
Corr. Mean				Corr. Mean		Barometer 29.43 Inches			
Mean Inst.	3413			Mean Inst.	52035	FIRING DRY 76 °F			
Max. Inst.	3430			Max. Inst.	54200	ROOM WET 66 °F			
Min. Inst.	3377			Min. Inst.	48000	R. H. 59 %			
Ex. Var.	53			Ex. Var.	6200	Instrument Room 76 °F			
Std. Dev.	16.0			Std. Dev.	1500	Ammunition 70 °F			
				Range Temperature 76 °F					
				Velocity Barrel Corr. F.S.					
				Pressure Barrel Corr. F.S.I.					
SHOT No.	DRY		WATERPROOF		VELOCITY IN GAGE		PRESSURE		CHECK AMMUNITION
									Value _____ F.S. _____ PSI
1	3428	53200							
2	3422	52700							
3	3420	53300							
4	3377	48000							
5	3396	49600							
6	3423	53000							
7	3425	52600							
8	3395	51700							
9	3423	52400							
10	3415	51400							
11	3414	51000							
12	3430	53000							
13	3421	53800							
14	3424	51800							
15	3417	52100							
16	3403	51400							
17	3379	51200							
18	3424	53500							
19	3429	54200							
20	3396	50800							
Total	68261	1040700							
Mean	3413	52035							
REMARKS:									
IMR 7005, AL 41313, Chg. 593.0									

LAKE CITY ARSENAL						Test Request Nr. 211253				
VELOCITY & PRESSURE - ACCEPTANCE REPORT										
Nomenclature Elec., 20MM (steel cases) (COLD TEST - CONDITIONED AT -65° F.)					Lot No IED 27-257 Group A (I)		Date Tested			
RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE			
				Elec.	64	742				
					Velocity Tested at 78 Feet					
VELOCITY F.S.				PRESSURE P.S.I.		Barometer 29.25 Inches				
DRY		WET				FIRING DRY 80 °F				
						ROOM WET 70 °F				
						R. H. 61 %				
Corr. Mean				Corr. Mean		Instrument Room 80 °F				
Mean Inst.	3364			Mean Inst.	54730	Ammunition 70 °F				
Max. Inst.	3411			Max. Inst.	60000	Range Temperature 80 °F				
Min. Inst.	3331			Min. Inst.	50700					
Ex. Var.	80			Ex. Var.	5300°					
Std. Dev.	25.0			Std. Dev.	3000	Velocity Barrel Corr. F.S.				
					Pressure Barrel Corr. P.S.I.					
SHOT No.	DRY		WATERPROOF		VELOCITY IN GAGE		PRESSURE		CHECK AMMUNITION	
									Value	F.S. PSI
1	3360	55500								
2	3340	52000								
3	3373	53500								
4	3391	59600								
5	3399	57800								
6	3354	53900								
7	3369	54200								
8	3342	52700								
9	3387	50700								
10	3362	54600								
11	3344	55100								
12	3411	58100								
13	3352	54400								
14	3366	52700								
15	3342	53000								
16	3393	60000								
17	3333	51800								
18	3380	56100								
19	3403	59400								
20	3331	42500								
Total	67287	1094500								
Mean	3364	54730								
REMARKS:										

LAKE CITY ARSENAL						Test Request Nr.	
VELOCITY & PRESSURE - ACCEPTANCE REPORT						211253	
Nomenclature					Lot No		Date Tested
Elec., 20MM (steel cases)					IED 27-257		
(COLD TEST - CONDITIONED AT -65° F.)					Group A (II)		
RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE
				Elec.	64	742	-
VELOCITY F.S.					Velocity Tested at 78 Feet		
DRY		WET	PRESSURE P.S.I.		Barometer 29.25 Inches		
Corr. Mean			Corr. Mean		FIRING DRY	80	° F
Mean Inst.	3355		Mean Inst.	53505	ROOM WET	70	° F
Max. Inst.	3391		Max. Inst.	36800	R. H.	61	%
Min. Inst.	3320		Min. Inst.	49600	Instrument Room	80	° F
Ex. Var.	71		Ex. Var.	7200	Ammunition	70	° F
Std. Dev.	18.0		Std. Dev.	2200	Range Temperature	80	° F
					Velocity Barrel Corr. F.S.		
					Pressure Barrel Corr. P.S.I.		
SHOT No.	DRY		WATERPROOF		VELOCITY IN GAGE		PRESSURE
							CHECK AMMUNITION
1	3354	54400					Value _____ F.S.
2	3368	55900					_____ PSI
3	3369	55800					
4	3342	52300					
5	3355	49600					
6	3364	56800					
7	3320	50600					
8	3347	52300					
9	3349	52400					
10	3370	53900					
11	3356	56600					
12	3342	51400					
13	3344	51400					
14	3348	54100					
15	3363	53500					
16	3325	50100					
17	3359	53100					
18	3364	52800					
19	3385	56700					
20	3391	56400					
Total	67095	1070100					
Mean	3355	53505					
REMARKS:							

LAKE CITY ARSENAL						Test Request Nr.	
VELOCITY & PRESSURE - ACCEPTANCE REPORT						211253	
Nomenclature					Lot No		Date Tested
Elec., 20MM (steel cases)					IED 27-257		
(COLD TEST - CONDITIONED AT -65° F.)					Group A (III)		
RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE
				Elec.	64	742	-
					Velocity Tested at 78 Feet		
VELOCITY F.S.					PRESSURE P.S.I.		
		DRY	WET			Barometer 29.25 Inches	
Corr. Mean				Corr. Mean		FIRING DRY 80 °F	
Mean Inst.	3361			Mean Inst.	53863	ROOM WET 70 °F	
Max. Inst.	3377			Max. Inst.	56100	R. H. 61 %	
Min. Inst.	3341			Min. Inst.	50100	Instrument Room 80 °F	
Ex. Var.	36			Ex. Var.	6000	Ammunition 70 °F	
Std. Dev.	11.0			Std. Dev.	1900	Range Temperature 80 °F	
					Velocity Barrel Corr. F.S.		
					Pressure Barrel Corr. P.S.I.		
SHOT No.	DRY °		WATERPROOF		VELOCITY IN GAGE		PRESSURE
CHECK AMMUNITION							
							Value _____ F.S.
							_____ PSI
1	3370	54500					
2	3364	56100					
3	3364	56000					
4	3375	56100					
5	3359	54400					
6	3349	55200					
7	3369	54100					
8	3356	52500					
9	3341	50100					
10	3344	54100					
11	3343	51300					
12	3361	52900					
13	3377	53800					
14	3371	55600					
15	3362	50600					
16	3364	54500					
17							
18							
19							
20							
Total	53769	861800					
Mean	3361	53863					
REMARKS:							
This last firing is four (4) short of regular test, due to misfires.							

LAKE CITY ARSENAL
VELOCITY & PRESSURE - ACCEPTANCE REPORT

Test Request Nr. 211253

Nomenclature

Elec., 20MM (steel cases)

(COLD TEST - CONDITIONED AT -65° F.)

Lot No

IED 27-257

Group B (I)

Date Tested

RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE
				Elec.	64	762	-

VELOCITY F.S.			PRESSURE P.S.I.		Velocity Tested at		
	DRY	WET			Barometer	29.25	Inches
Corr. Mean			Corr. Mean		FIRING DRY	80	°F
Mean Inst.	3369		Mean Inst.	53095	ROOM WET	70	°F
Max. Inst.	3396		Max. Inst.	56100	R. H.	61	%
Min. Inst.	3354		Min. Inst.	49200	Instrument Room	80	°F
Ex. Var.	42		Ex. Var.	6900	Ammunition	70	°F
Std. Dev.	11.0		Std. Dev.	1900	Range Temperature	80	°F
					Velocity Barrel Corr.		F.S.
					Pressure Barrel Corr.		P.S.I.

SHOT No.	DRY		WATERPROOF		VELOCITY IN GAGE		PRESSURE		CHECK AMMUNITION	
									Value	F.S.
1	3356	55600								PSI
2	3396	56100								
3	3389	55700								
4	3369	51100								
5	3364	52600								
6	3361	53000								
7	3376	53000								
8	3364	53300								
9	3354	49200								
10	3368	49900								
11	3378	53800								
12	3371	53700								
13	3365	54000								
14	3380	54100								
15	3363	53600								
16	3382	55900								
17	3355	51100								
18	3363	52400								
19	3364	51600								
20	3354	52200								
Total	67372	1061900								
Mean	3369	53095								

REMARKS:

LAKE CITY ARSENAL
VELOCITY & PRESSURE - ACCEPTANCE REPORT

Test Request Nr.
211253

Nomenclature

Elec., 20MM (steel cases)
(COLD TEST - CONDITIONED AT -65° F.)

Lot No

IED 27-257
Group B (II)

Date Tested

RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE
				Elec.	64	762	—

VELOCITY F.S.			PRESSURE P.S.I.		Velocity Tested at	
	DRY	WET			Barometer	78 Feet
Corr. Mean			Corr. Mean			29.25 Inches
Mean Inst.	3367		Mean Inst.	52425	FIRING DRY	80 °F
Max. Inst.	3397		Max. Inst.	56100	ROOM WET	70 °F
Min. Inst.	3333		Min. Inst.	47600	R. H.	61 %
Ex. Var.	64		Ex. Var.	8500	Instrument Room	80 °F
Std. Dev.	15.0		Std. Dev.	1900	Ammunition	70 °F
					Range Temperature	80 °F
					Velocity Barrel Corr.	F.S.
					Pressure Barrel Corr.	P.S.I.

SHOT No.	DRY		WATERPROOF		VELOCITY IN GAGE		PRESSURE		CHECK AMMUNITION	
									Value	F.S. PSI
1	3333	47600								
2	3362	51000								
3	3370	53800								
4	3369	53000								
5	3363	51200								
6	3397	56100								
7	3393	55500								
8	3372	53000								
9	3380	52800								
10	3352	51600								
11	3345	49700								
12	3350	52100								
13	3362	52900								
14	3368	52500								
15	3379	53600								
16	3357	52100								
17	3369	53200								
18	3369	54300								
19	3376	51000								
20	3366	51500								
Total	67332	1048500								
Mean	3367	52425								

REMARKS:

Test Request Nr. 211253

PROPELLANT			LAKE CITY ARSENAL				LOT NO. IED 27-257A			
TYPE	A L NO.	CHG	ACTION TIME - ACCEPTANCE REPORT				PRIMER TYPE M52A3B1			
IMR 7005	41313	593	CALIBER & TYPE				PRIMER LOT NO.			
			Ctg., 20MM, Pa11, M55A1				BARREL TYPE Mann			
			SPECIFICATION		REV	AND	BARREL NO. 114			
			DATE OF TEST				RDS. ON BARREL 725			
ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	
1 2.72	26 2.61	51 2.72	76 2.72	101	126	151	176			
2 2.36	27 2.71	52 2.74	77 2.73	102	127	152	177			
3 2.63	28 2.69	53 2.64	78	103	128	153	178			
4 2.64	29 2.65	54 2.69	79	104	129	154	179			
5 2.45	30 2.75	55 2.60	80	105	130	155	180			
6 2.83	31 2.79	56 2.76	81	106	131	156	181			
7 2.62	32 2.61	57 2.67	82	107	132	157	182			
8 2.65	33 2.76	58 2.70	83	108	133	158	183			
9 2.61	34 2.65	59 2.82	84	109	134	159	184			
10 2.63	35 2.68	60 2.66	85	110	135	160	185			
11 2.72	36 2.76	61 2.66	86	111	136	161	186			
12 2.69	37 2.80	62 2.73	87	112	137	162	187			
13 2.58	38 2.75	63 2.72	88	113	138	163	188			
14 2.69	39 2.69	64 2.66	89	114	139	164	189			
15 2.66	40 2.71	65 2.71	90	115	140	165	190			
16 2.59	41 2.71	66 2.69	91	116	141	166	191			
17 2.73	42 2.73	67 2.84	92	117	142	167	192			
18 2.73	43 2.73	68 2.79	93	118	143	168	193			
19 2.69	44 2.66	69 2.60	94	119	144	169	194			
20 2.74	45 2.59	70 2.80	95	120	145	170	195			
21 2.77	46 2.62	71 2.84	96	121	146	171	196			
22 2.57	47 2.67	72 2.62	97	122	147	172	197			
23 2.68	48 2.65	73 2.62	98	123	148	173	198			
24 2.60	49 2.73	74 2.63	99	124	149	174	199			
25 2.59	50 2.74	75 2.73	100	125	150	175	200			
TOTAL			207.03							
MEAN			2.69							
			RECORD	LIMIT						
2.84			FIRED BY							
2.45			RECORDED BY							
EYE VARIATION .39										

REMARKS

(COLD TEST - CONDITIONED AT -65° F.)

Twenty-three (23) rounds failed to fire.

PROPELLANT			LAKE CITY ARSENAL				LOT NO. IED 27-257B							
TYPE	A L NO.	CHG	ACTION TIME - ACCEPTANCE REPORT				PRIMER TYPE M52A3B1							
IMR 7005	41313	593					PRIMER LOT NO.							
			CALIBER & TYPE				BARREL TYPE Mann							
			Ctg., 20MM, Ball, M55A1				BARREL NO. 114							
			SPECIFICATION				REV AND							
			DATE OF TEST				RDS. ON BARREL 560							
ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	
1	2.77	26	2.57	51		76		101		126		151		176
2	2.65	27	2.59	52		77		102		127		152		177
3	2.57	28	2.58	53		78		103		128		153		178
4	2.60	29	2.61	54		79		104		129		154		179
5	2.59	30	2.57	55		80		105		130		155		180
6	2.57	31	2.60	56		81		106		131		156		181
7	2.59	32	2.62	57		82		107		132		157		182
8	2.61	33	2.60	58		83		108		133		158		183
9	2.61	34	2.55	59		84		109		134		159		184
10	2.58	35	2.67	60		85		110		135		160		185
11	2.59	36	2.57	61		86		111		136		161		186
12	2.63	37	2.57	62		87		112		137		162		187
13	2.67	38	2.58	63		88		113		138		163		188
14	2.59	39	2.60	64		89		114		139		164		189
15	2.52	40	2.63	65		90		115		140		165		190
16	2.58	41	2.77	66		91		116		141		166		191
17	2.61	42	2.64	67		92		117		142		167		192
18	2.55	43	2.62	68		93		118		143		168		193
19	2.53	44	2.66	69		94		119		144		169		194
20	2.53	45	2.61	70		95		120		145		170		195
21	2.59	46	2.70	71		96		121		146		171		196
22	2.60	47	2.64	72		97		122		147		172		197
23	2.58	48	2.66	73		98		123		148		173		198
24	2.67	49	2.60	74		99		124		149		174		199
25	2.69	50	2.61	75		100		125		150		175		200
TOTAL		130.49												
MEAN		2.61												
MAX		2.77		RECORD		LIMIT		FIRED BY						
MIN		2.52						RECORDED BY						
EXTREME VARIATION		0.25												
REMARKS														
(AMBIENT TEST)														

PROPELLANT			LAKE CITY ARSENAL				LOT NO. IED 27-257A				
TYPE	AL NO.	CHG	ACTION TIME - ACCEPTANCE REPORT				PRIMER TYPE M52A3B1				
IMR 7005	41313	593	CALIBER & TYPE				PRIMER LOT NO.				
			Ctg., 20MM, Ball, M55A1				BARREL TYPE Mann				
			SPECIFICATION				BARREL NO. 114				
			DATE OF TEST				RDS. ON BARREL				
ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME
1	2.70	26	2.57	51	2.52	76	2.58	101		126	151
2	2.65	27	2.62	52	2.53	77	2.61	102		127	152
3	2.62	28	2.67	53	2.59	78	2.61	103		128	153
4	2.59	29	2.63	54	2.57	79	2.51	104		129	154
5	2.69	30	2.61	55	2.59	80	2.59	105		130	155
6	2.64	31	2.61	56	2.58	81	2.55	106		131	156
7	2.56	32	2.60	57	2.60	82	2.59	107		132	157
8	2.63	33	2.59	58	2.59	83	2.56	108		133	158
9	2.58	34	2.62	59	2.66	84	2.63	109		134	159
10	2.69	35	2.61	60	2.56	85	2.72	110		135	160
11	2.57	36	2.58	61	2.67	86	2.63	111		136	161
12	2.63	37	2.64	62	2.64	87	2.59	112		137	162
13	2.65	38	2.61	63	2.65	88	2.62	113		138	163
14	2.64	39	2.62	64	2.60	89	2.59	114		139	164
15	2.55	40	2.64	65	2.59	90	2.64	115		140	165
16	2.63	41	2.61	66	2.56	91	2.61	116		141	166
17	2.66	42	2.62	67	2.63	92	2.56	117		142	167
18	2.64	43	2.58	68	2.53	93	2.69	118		143	168
19	2.66	44	2.58	69	2.59	94	2.59	119		144	169
20	2.75	45	2.52	70	2.60	95	2.58	120		145	170
21	2.56	46	2.64	71	2.57	96	2.62	121		146	171
22	2.59	47	2.63	72	2.60	97	2.61	122		147	172
23	2.61	48	2.62	73	2.67	98	2.61	123		148	173
24	2.67	49	2.61	74	2.60	99	2.60	124		149	174
25	2.54	50	2.60	75	2.60	100	2.65	125		150	175
TOTAL			261.14								
MEAN			2.61								
MAX			RECORD		LIMIT		FIRED BY				
MIN											
EXTREME VARIATION							RECORDED BY				
REMARKS											
(AMBIENT TEST)											
Thirteen (13) rounds failed to fire.											

Nomenclature

Lot No

Date Tested _____

IED 27-257A
IED 27-257B

REMARKS:

LMR 7006, AL 41313, Chg. 593 grs.
VELOCITY

PRESSURE

IED-MIR NO 144

MALFUNCTION INVESTIGATION REPORT

AMMUNITION LOT NO: 27-257 B QUANTITY 2
TYPE OF MALFUNCTION MISFIRE REQUESTED BY
AMMUNITION TYPE 20 MM INVESTIGATION BY
APPLICABLE SIP: FAPD NO. SP-19

INSPECTION RESULTS

PRIMER ASSEMBLY
VISUAL EXAMINATION.

SAMPLE

- NO. 1. Top edge of outer cup deeply scratched all the way around. Button deeply scratched.
2. Punch out in outer cup not complete; extends over insulator approximately 1/5 it's circumference. Does not touch button, but button has what appears to be a scorched spot on it, indicating that there had been a connection between outer cup and button and that it burned off.

GAGING

SAMPLE NO.	ASSEMB. HEIGHT	DIA.O. CUP	BRIDGE THICK	BUTTON DEPTH
	1. .238	.3305	.179	.0035
	2. .244	.3305	.151	.007

RESISTANCE

SAMPLE NO. 1. 400,000 Ohms.
2. 16,000 "

PELLET

CONDITION	WEIGHT
1. Very soft pellet, no consolidation, appeared moist, moisture content checked at .27%.	2.72
2. Normal appearing pellet	2.84.

REMARKS

Listed below are resistance values as recorded by the Aberdeen Proving Ground chronograph ohmmeter for misfires encountered in the test.

Lot IED 27-257A:

<u>Ambient Test</u>	<u>Cold Test</u>
<u>Ohms Resistance</u>	<u>Ohms Resistance</u>
3.0 meg.	5.0 meg.
2.5 meg.	3.2 meg.
7.5 meg.	5.1 meg.
6.0 meg.	5.3 meg.
4.6 meg.	10.0 meg.
9.2 meg.	7.2 meg.
1.6 meg.	3.6 meg.
9.3 meg.	8.3 meg.
4.2 meg.	9.7 meg.
11.0 meg.	7.0 meg.
500 K (500,000)	11.6 meg.
17.0 meg.	46.0 meg.
3.6 meg.	7.5 meg.
1.3 meg.	700 K (700,000)
10.5 meg.	32.0 meg.
2.5 meg.	26.0 meg.
11.0 meg.	10.7 meg.
4.2 meg.	1.0 meg.
2.4 meg.	4.8 meg.
7.6 meg.	7.3 meg.
11.5 meg.	10.7 meg.
20.0 meg.	6.0 meg.
	6.2 meg.
	13.0 meg.
	4.0 meg.
	6.6 meg.
	5.8 meg.

Lot IED 27-257B:

<u>Ambient Test</u>
<u>Ohms Resistance</u>
12 K
7.5 meg.

APPENDIX B

VELOCITY, PRESSURE AND ACTION TIME CHARTS

CHART A

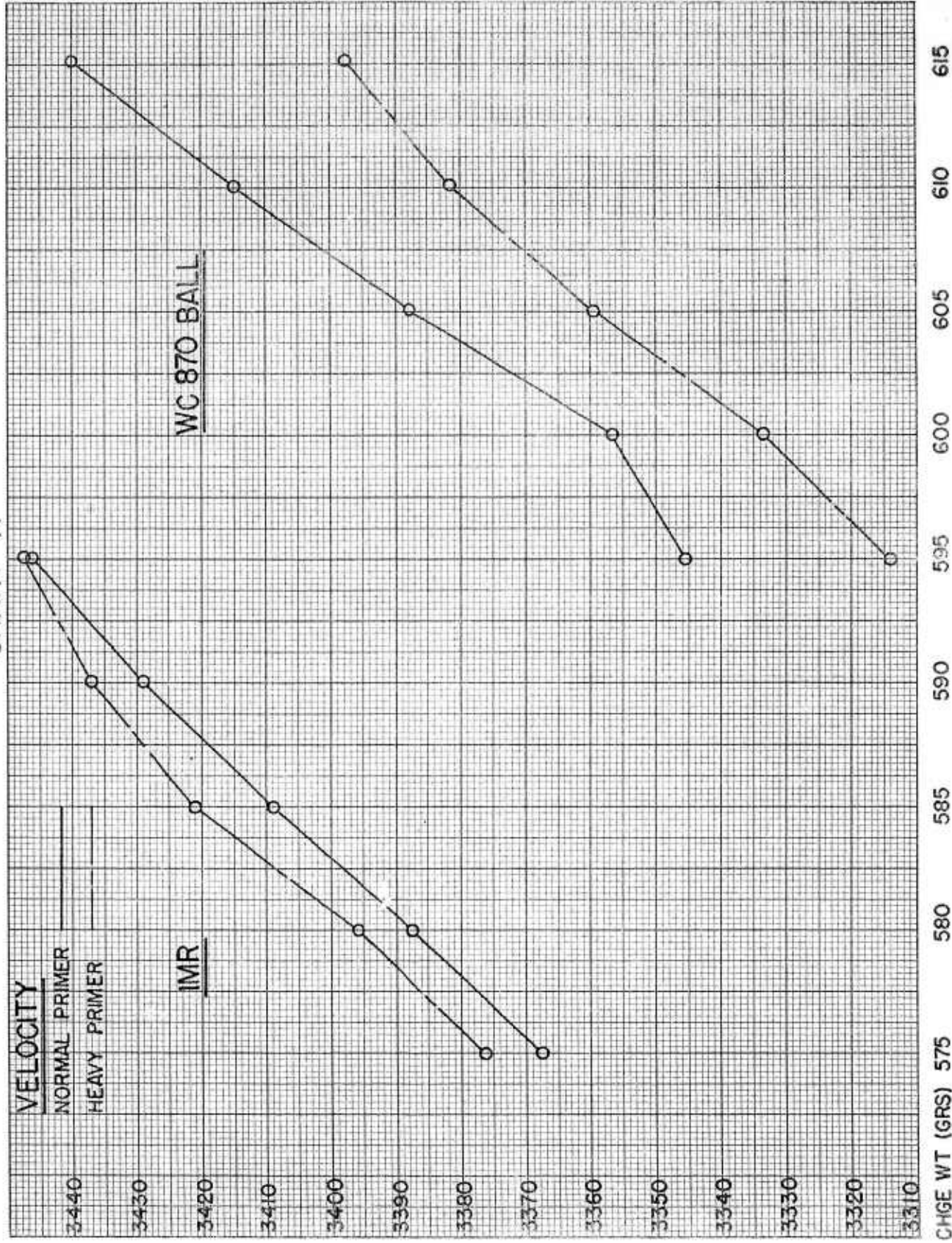


CHART B

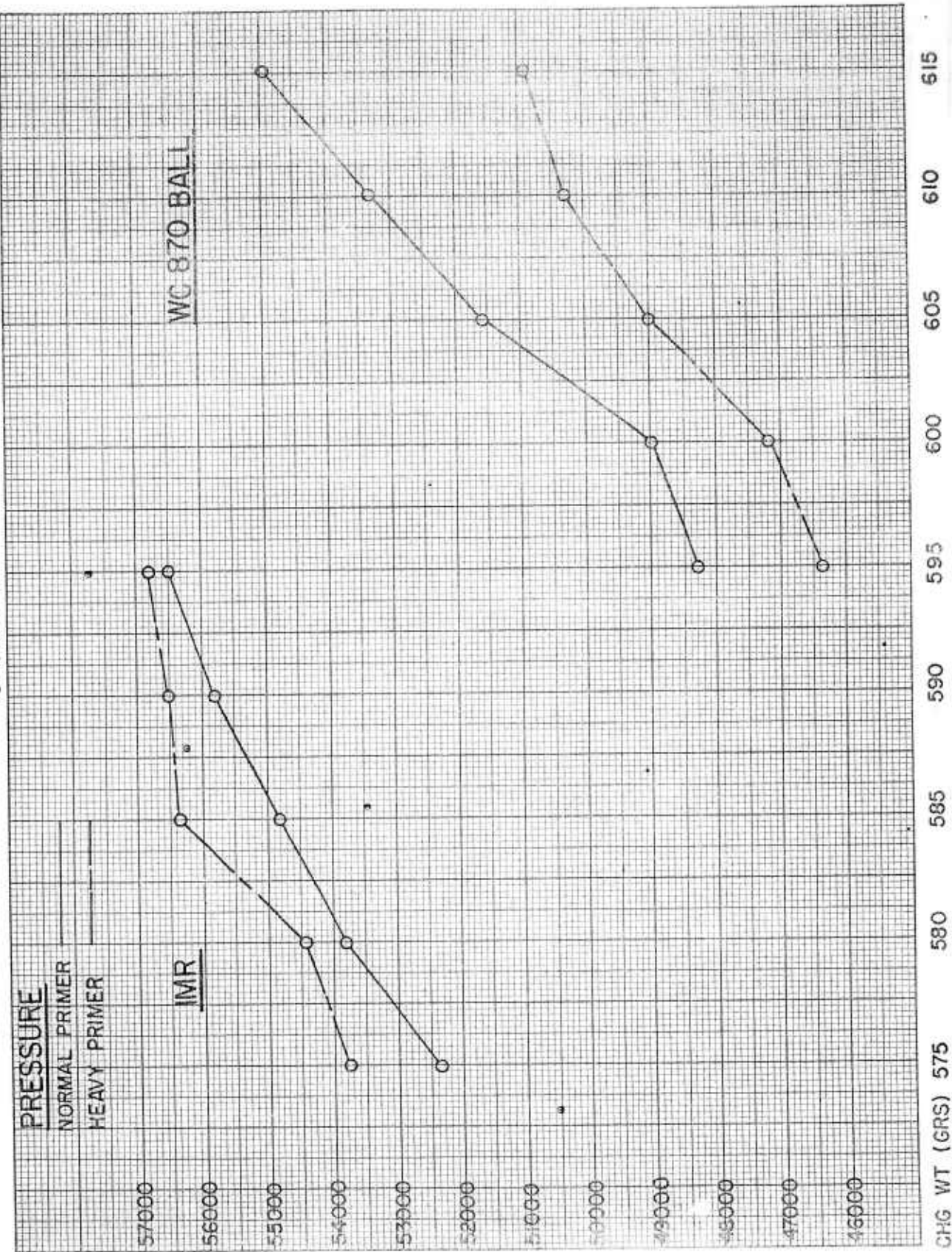
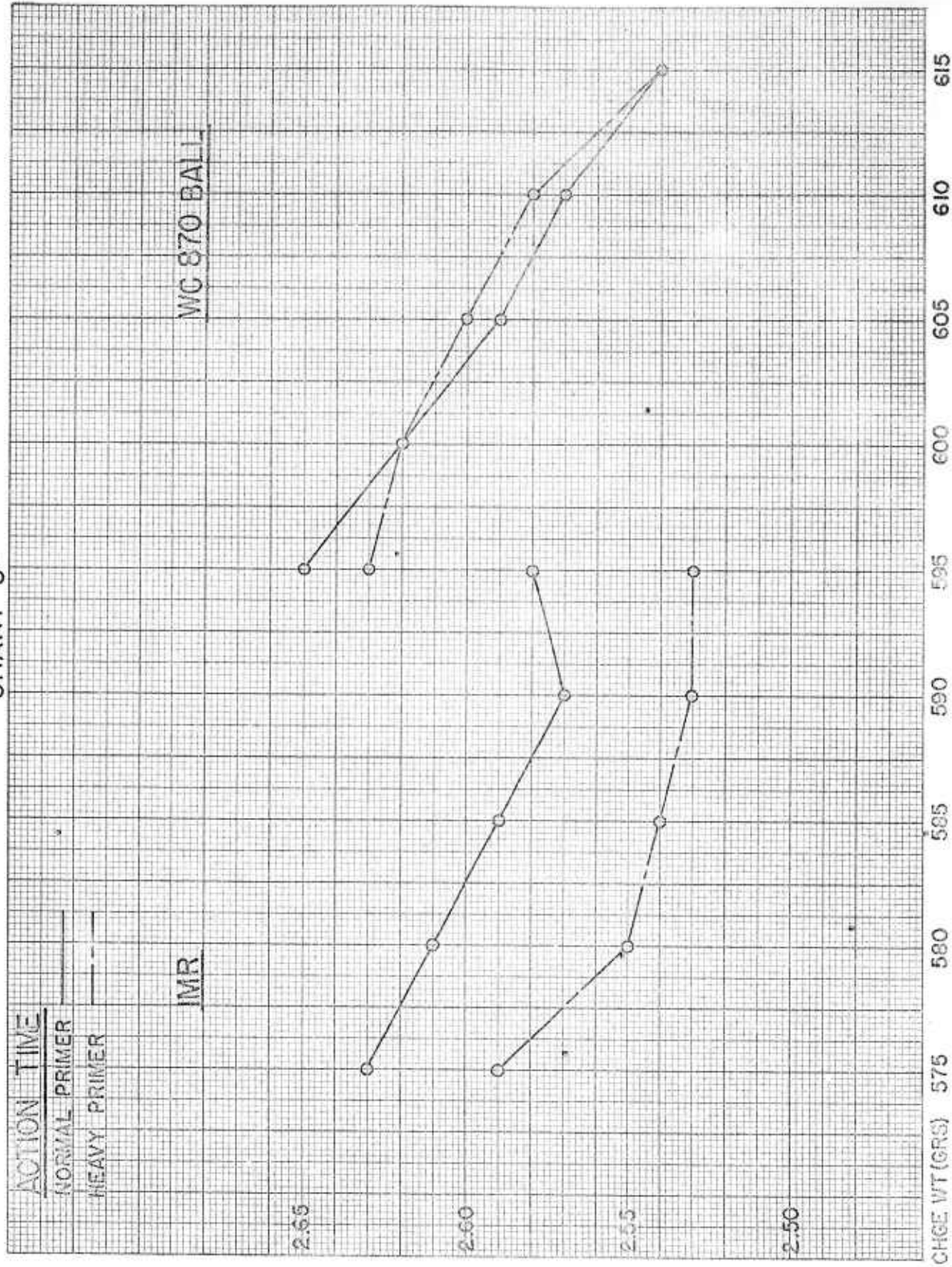


CHART C



APPENDIX C
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